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neering opportunities and requirements, discussions of teaching problems, excursions to other plants and social meetings. This course gives engineering teachers an opportunity to become acquainted with the latest developments in electrical power apparatus, with shop methods in use in large manufacturing concerns, and to meet and exchange ideas on teaching subjects with other engineering teachers of experience. Since the Westinghouse company draws men from engineering schools, it is of advantage to it that students may know not only of the opportunities open but of methods of working efficiently in its organization.

#### UNIVERSITY AND EDUCATIONAL NEWS

DR. JOHN R. MURLIN, for eight years assistant professor of physiology in the medical school of Cornell University, has been appointed director of the new department of vital economics at the University of Rochester. This department is being organized from funds made available by the will of Lewis P. Ross, whose will gave to the university the residuary estate of more than \$800,000, the income only to be used "to the end that human life may be prolonged with increased health and happiness." The trustees were instructed to expend that income for two purposes—to contribute toward the support, improvement, and extension of the department of household economics of the Mechanics' Institute of Rochester, and to establish in the university a department of vital economics. Dr. Murlin is now a major in the Sanitary Corps of the national army, and head of the food division in the surgeon general's office.

THE school of engineering of the Pennsylvania State College has the largest freshman enrollment in its history, numbering 271 as compared to 210 at this time last year. The upper classes are from 50 to 75 per cent. of normal, due to the large number who volunteered last spring.

PROFESSOR GEORGE H. PERKINS, dean of the College of Arts and Sciences of the University of Vermont and professor of natural

history, has been designated as acting president for the next year. President Guy Potter Benton has been granted a year's leave of absence by the trustees in order to comply with the request of the National War Work Council to aid in the coordination and direction of the council's work in Europe. President Benton sailed early in September in charge of a force of thirty Young Men's Christian Association men.

ALBERT RUSSELL MANN, professor of rural social organization, and acting dean has been appointed dean of the New York State College of Agriculture at Cornell University.

DR. C. P. FITCH, of the New York State Veterinary College, has been appointed professor of comparative pathology and bacteriology and chairman of the division of veterinary medicine in the department of agriculture, University of Minnesota.

THE following promotions have been made at the school of medicine, Western Reserve University: Paul J. Hanzlik, to be assistant professor of pharmacology; Cyrus Hartwell Fiske, to be assistant professor of biochemistry; Roy Wesley Scott, to be associate in physiology; Julius Moses Rogoff, to be senior instructor in experimental medicine; Roy Bartlett Metz, to be associate in ophthalmology; Joseph Edgar McClelland, to be instructor in pediatrics; Carlos Eugene Pitkin, to be instructor in diseases of the nose, ear and throat; Chester Dale Christie, to be instructor in medicine; Marion Blakenhorn, to be instructor in medicine.

PROFESSOR N. C. CURTIS, of Tulane University, has been appointed associate professor of architectural design in the University of Illinois.

DR. R. M. STRONG has been promoted from associate professor of anatomy to professor of microscopic anatomy in the medical school of Vanderbilt University.

DR. O. VAN DER STRICHT, professor of histology and embryology at Ghent, Belgium, who for the past two years has held the post of fellow in cytology in the anatomical laboratory of Western Reserve University, has been

appointed lecturer in anatomy at the Johns Hopkins University.

## DISCUSSION AND CORRESPONDENCE

### WHEN IS A FORCE NOT A FORCE?

IN his communication to SCIENCE for March 16, 1917, Mr. A. H. Patterson very pertinently calls attention to the vagueness, lack of precision and error in the treatment of the force concept by current physics text-books. Much of Mr. Patterson's criticism deals with Newton's third law of motion and appears to be based on a misinterpretation of that law. To this I wish to call attention.

Force is always exerted by one portion of matter, *A*, upon a second portion of matter *B*. These may be distinct bodies or parts of the same body. If *A* exerts a force on *B* then, the third law tells us, *B* exerts an equal force in the opposite direction on *A*. If the force of *A* on *B* is called the action, the force of *B* on *A* is called the reaction. The action and reaction do not act on the same body or body-part. Failure to fully appreciate this seems to be responsible for the present as well as many other misinterpretations of the third law.

Mr. Patterson asks: "What is a student to think when he is told that to *every* action there is *always* an equal and contrary action, and is then informed that (only) an unbalanced force acting on a mass produces acceleration?" The two statements are mutually consistent and true. In order to safeguard the student against some of the pitfalls which are dangerous even to his teachers it is only necessary to make the information more complete.

Mr. Patterson's problems may well serve this purpose. The ball at the end of a rubber band is the first of these. Let us ignore the effect of gravity. When the ball is whirled about in a circular path at uniform speed the pull exerted by the rubber band *on the ball* is called the centripetal force. No other balanced force and gives rise to an acceleration which manifests itself in the change in direction of the velocity. The equal and contrary action is the outward pull of the

ball *on the string*, known as the centrifugal force. The string is not accelerated because the pull of the support at the fixed end is equal and opposite to the centrifugal pull at the free end. The forces on the string are balanced.

A porter pushes a truck at uniform speed over level ground. Then the force which he exerts forward on the truck is equal to the backward frictional force. If this frictional resistance were suddenly to vanish, the forward force exerted on the truck by the porter would be the only horizontal force, hence unbalanced and a forward acceleration would result. Both with and without friction the truck pushes backward on the porter with an equal force. In addition to pushing forward on the truck the porter is pushing backward on the ground with his feet, and consequently the ground is pushing him forward. If the forward push of the ground and the backward push of the truck are equal the forces on the porter are balanced and he moves without acceleration. Everywhere the forces act in pairs, because there must be an exacter of the force and a body on which it is exerted. Newton's law has a meaning only when both bodies are considered.

Newton's third law requires no distinction between inertia-reactions and other forces. To introduce them serves to complicate rather than to simplify. The following problem utilizes Mr. Patterson's method, quoting freely from the closing paragraphs of his communication.

A mass *M* rests on a perfectly smooth horizontal surface. To *M* we apply a horizontal force *F*. Being the only horizontal force it is unbalanced. It is opposed by an inertia reaction *which can in a sense balance it, but can not hold it in equilibrium because a force opposed only by inertia reaction always produces acceleration*.

It is difficult to see the need of this devitalized form of the third law, either from the point of view of principle or of practice. Forces do always exist in pairs, yet the forces on either or both of two bodies between which force-action exists may be unbalanced.